Working Draft

Monitoring Streambanks and Riparian Vegetation

Multiple Indicator Monitoring
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Introduction

The purpose of the protocol is to provide an efficient suite of monitoring procedures that, along with current livestock grazing management practices (timing, frequency, intensity and duration), can be used to determine if the riparian vegetation and streambanks are responding as anticipated in a timely manner. Appropriate vegetative cover and streambank stability is essential for water quality and aquatic habitat. Monitoring effects of current year grazing practices provides information necessary to make adjustments to grazing practices necessary to maintain or improve riparian and streambank conditions. However, short-term monitoring alone does not provide the data necessary to determine condition and trend. The protocol also provides monitoring procedures that measure changes to riparian vegetation and streambanks.

Adaptive management requires knowledge of the current conditions, potential or capability of riparian sites, current management, effects of the management on the resources, and possible management changes that may be made to move the current condition toward the desired condition. Single indicators of condition or trend are usually not adequate to make good decisions. Information on the condition and trend of the vegetation and streambank plus the current management help establish "cause-and-affect" relationships that are important to make appropriate decisions.

This monitoring protocol provides methods for six indicators for stream associated riparian areas. Three of the indicators: modified greenline, modified woody species regeneration, and streambank stability, provide data and information concerning the present condition and trend of riparian vegetation and streambanks are called effectiveness monitoring. Monitoring procedures for vegetation include modifications of methods described by Winward (2000) and Coles-Ritchie *et al* (2003). Streambank stability is a modification of the method described by Henderson *et al* (2003).

Monitoring implementation the management practices includes modified Extensive Browse Utilization (Interagency Technical References, 1996), modified stubble height described in Interagency Technical Reference (1996) and Challis Resource Area (1999), and streambank alteration described by Cowley (2004). This is called implementation monitoring. These procedures provide information that helps make short, year-to-year, adjustments to livestock grazing management practices necessary to meet management objectives

Preliminary field studies indicate that procedures described in this protocol provide information useful for making decisions in the adaptive management process. Table 1 provides a summary of information derived from using the protocols described in this document for two sites: a highly disturbed site and moderately grazed site. Comparisons were made between continuous measurements and plots. Greenline vegetation in the moderately grazed site had 79 percent agreement with the moderately grazed site (see Appendix A), while greenline vegetation on the highly disturbed site was 99 percent. One site had complex vegetation and streambank conditions. While the second site was relatively uniform. Using a defined area of the plot tends

to focus the determination of the vegetation community type more closely. Some small isolated community types were missed using the plot.

Table 1—Comparison of data obtained from a highly disturbed site and a moderately grazed site.

Highly disturbed Site		Moderately Grazed Site	
% hydric vegetation=	10%	% hydric vegetation=	68%
% Stable banks=	2%	% Stable banks=	62%
% Covered banks=	90%	% Covered banks=	90%
Stubble Height=	1.6	Stubble Height=	4
Percent altered=	82.83	Percent altered=	22.89
Woody Use=	70-100%	Woody Use=	0-30%

Selecting Designated Monitoring Areas

Designated monitoring area (DMA) is the location in riparian areas and along the streambanks where monitoring takes place. DMAs are not key areas, rather they are that are monitored to provide information concerning the management of critical areas such as riparian areas. Instead they should be representative of grazing use specific to the riparian area being assessed and should reflect what is happening in overall riparian areas as a result of on-the-ground management actions. It should not reflect an average amount of use in all riparian areas of the stream reaches in the pasture but rather reflect livestock use only in those stream reaches where livestock are actually using riparian areas (see Appendices I and J).

The following criteria are used to select DMAs.

- DMAs represent riparian areas used by livestock. Select the site based on the premise that if proper management occurs on the area, the remainder of the riparian areas within a pasture or use area will also be managed within requirements.

- Select sites that are representative of use, not an average for the stream within the pasture or allotment. For example, if one-half mile of a stream reach in the pasture is used by livestock and one mile is not used because it is protected by vegetation, rock, debris, or topography, the DMA location should represent the stream reach that livestock use.

- Monitoring sites should have the potential to respond to and measure changes in grazing management. Livestock trails associated with livestock use of the riparian may be included in the DMA.

- Avoid selecting sites on which vegetation is not a controlling factor such as cobble, boulder, and bedrock armored channels.

- Do not place DMA in streams over four percent gradient unless they have or should have distinct developed flood plains.

- Avoid water gaps and small trail areas, e.g., along fences, that do on represent livestock grazing use along the riparian area. These areas may be monitored to determine changes

over time, but should not be considered as representing the riparian area. This monitoring usually documents changes that occur when physical improvements such as hardening water gaps and trails with gravel to reduce adverse impacts at the site.

Training

Training is essential for personnel conducting monitoring. Studies have found crews who were trained substantially increased the precision and repeatability of the procedures.

Transects

Transects should be permanently marked. Reference markers, e.g., steel posts, should be at least 30 meters (100 feet) away from the plot location. Since these transects are along the greenline and the greenline moves with the stream, markers should be placed a sufficient distance from eroding banks to reduce the risk of losing the marker. Transects should be at least 100 meters (328 feet) long. Permanently mark starting and ending points on each side of the stream.

Monitoring Procedures

Monitoring usually begins at the lower end of the transect on the right hand side (looking up stream).

1. Beginning at the transect marker, take two paces (four steps) along the greenline and place the monitoring frame down at the toe of the boot with the center bar along the greenline (see Appendix B). This will place one modified Daubenmire monitoring frame on each side of the greenline.

2. Using the appropriate technique(s) described in this protocol, measure and record the appropriate data. Continue along the greenline placing the monitoring frame frame down each monitoring frame (two steps). When the upper transect marker is reached, cross the stream and continue the procedure down the other side to the end marker.

3. The procedure should not be used if a high flow (flood) event occurs prior to doing the monitoring. In that situation, water's energy and sediment will make it difficult, if not impossible, to determine if the effects are a result of the current grazing season or past grazing season.

Effectiveness Monitoring

Effectiveness monitoring is designed to answer the question, Are the management practices currently applied to the area, achieving the desired results? These procedures are designed to measure changes in vegetation and streambank stability over time, i.e., trend. Effectiveness monitoring is usually conducted every three to five years on riparian areas and streambanks. This period of time is usually necessary to detect changes.

Greenline (Modified)

Objective: Estimate the vegetation composition along the greenline by riparian community type or dominate vegetation.

The greenline is the first relatively continuous lineal grouping of rooted perennial vegetation that is at least 12 inches wide and has at least 50 percent vegetative cover. Greenlines are usually slightly below the bankfull flow. They are approximately parallel to the stream flow, not perpendicular. (see Appendix B, Figure 6) The greenline is defined along the base of the plants and not at the edge of the vegetation canopy (see Appendix B, Figure 1). Appendix B provides examples of greenline location.

General Instructions

- The greenline may be submerged during high (above bankfull) flow and may be some distance away from water during low flow.

- Bare ground or sparsely vegetation areas under a shrub canopy is not considered the greenline. The base of the shrub is the green line. (see Appendix A, Figure 1)

- When banks are eroding or when a stream becomes entrenched, the greenline may be located high above the stream and consist of upland plants. Record the upland species as the greenline because they are the first perennial vegetation. (see appendix A, Figures 2, 9, and 11)

- The main channel banks and not islands are monitored. Consider islands at bankfull flow even though at low flow channels may be dry at base or low flow. (see Appendix B, Figure 3)

- Greenline does not occur on unstable slump features. (see Appendix B, Figures 2, 6, and 7)

Specific Instructions

1. Evaluate the vegetation within the monitoring frame on the floodplain side of the greenline.

2. At each plot, identify and record the overstory, dominant, co-dominant, and/or sub-dominant vegetation. Overstory and dominant and co-dominant plant species are separated by a forward slash. The sub-dominant is indicated by parenthesis. An example of an overstory with co-dominant vegetation in the understory is Sabo/Juba/Popr (*Salix boothii/Juncus balticus/Poa pratensis)*. An overstory with a dominant and sub-dominant understory example would be Sabo/Popr(Caut) (*Salix boothii/Poa pratensis(Carex utriculata*).

3. Record data on the Greenline form (see Appendix H - 5) by dominant vegetation (community type) to the nearest 0.5 monitoring frame on the field form or in a computer.

At least 25 percent of the monitoring frame must be one vegetative type to be recorded as 0.5 monitoring frame. When two vegetation types are in the plot and one type is less than 25 percent, record only the majority type.

4. Record shrub or tree overstory when the monitoring frame is within the drip line of the shrub or tree (see Appendix B, Figure 4)

A continuous measurement along the greenline as described by Winward (2000) may also be used.

Woody Species Regeneration (Modified)

Objective: Estimate the species, number, and age-class of woody species plants within one meter either side of the greenline.

1. The woody species regeneration plot is 1 meter by 0.4 meters on each side of the greenline.

2. Place the monitoring frame perpendicular to the greenline and count the number of woody plants by species rooted within the monitoring frame and record on the form shown in Appendix H. (Do not count woody species canopy cover as woody species within the plot.)

3. Move the monitoring frame away from the greenline and place it at the end of the first monitoring frame and repeat the procedure (see Figure 1).

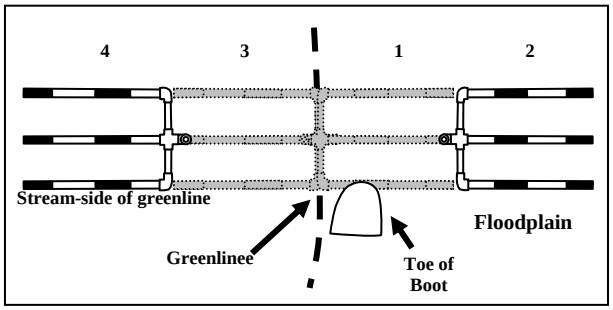

Figure 1—Woody species regeneration plot is 0.4 meters by 1.0 meter. The plot is defined by placing the monitoring frame perpendicular to the greenline. The frame is placed end-to-end on each side of the greenline. The numbers indicate the sequence of frame placement to determine the amount of woody species regeneration.

Streambank Stability

General Description

Streambank stability is measured using a pace-plot transect and is expressed as a percentage of the streambank in one of six stability classes (see below). It is intended for long-term trend monitoring and should read on 3 to 10 year intervals.

Streambank Stability Classification

Use Appendices B, C, D, and E. Record the data on the appropriate "Streambank Stability" form in Appendix H by one of the following six bank stability classes:

CS - Covered and stable (non-erosional). Streambanks are covered with perennial, and/or cobble (6 inches or bigger), boulders, bedrock or anchored wood (4 inches in

diameter or larger) to protect them from the erosive effects of water. Streambanks do not have indications of erosion, breakdown, shearing, or trampling that exposes plant roots. Banks associated with gravel bars having perennial deep-rooted vegetation along the edge of the floodplain line are in this category.

CU - Covered and unstable (vulnerable). These streambanks are covered with perennial vegetation and occur where undercutting by water may cause breakdown, slumping, nicks, bank shearing, and/or fracturing along the bank.

US - Uncovered and stable (vulnerable). Streambanks having consolidated soils high in clay, particularly in the lower part of the streambank, may be uncovered and stable. These banks are vulnerable to high flows, particularly winter flows with floating ice. Uncovered, stable banks may also be compacted streambanks trampled by concentrations of ungulates, people trails, vehicle crossings, or other activities that cause compaction. Such disturbance flattens the bank so that slumping and breakdown does not occur even though vegetative cover is significantly reduced or eliminated.

UU - Uncovered and unstable (erosional & depositional). These are bare, eroding streambanks and include all banks mostly uncovered that are at a steep angle to the water surface. When the bank is not present due to excessive bar deposition or to stream side trampling, the bank will be classified "uncovered/unstable."

FB - False Bank (vulnerable). Stream banks have slumped in the past but have been stabilized by relatively shallow-rooted vegetation. These banks are usually lower than existing banks are covered/unstable. False banks vegetated with deep-rooted riparian vegetation may be considered stable and should be counted separately and added to the stable category.

UN - Unclassified. Side-channels, tributaries, springs, road crossings, etc. cause a break in a streambank. Livestock or wildlife trails are not included in this category.

Streambank Cover

Streambanks are considered covered if they show any of the following features:

1) Perennial herbaceous and/or woody vegetation provides more than 50 percent ground cover the vertical height of the streambank (Bauer and Burton, 1993).
2) Roots of vegetation cover more than 50 percent of the bank (deep rooted plants such as willows and sedges provide such cover).
3) Cobble size rocks (at least 6 inches in diameter), boulders, or bedrock cover more than 50 percent of the streambank surfaces.
4) Logs, at least four inches in diameter, cover more than 50 percent of the bank surfaces. At least 50 percent of the bank surfaces are protected by a combination of the above.

Streambank Stability

Streambanks are considered stable if they do not show indications of any of the following features:

1) Breakdown - Obvious blocks of streambanks broken away and lying adjacent to the bank breakage.
2) Slumping or False Bank - Bank has obviously slipped down, cracks may or may not be obvious, but the slump feature is obvious.
3) Bank Shearing - occurs when animals walk along the streambank or cross the stream and shear or break off portions of the streambank. It is recognized by a shear plane with obvious hoof marks on the streambank. Included the total length of bank disturbance associated with the shearing.
4) Fracture - A crack is visibly obvious on the bank indicating that the block of bank is about to slump or move into the stream.
5) Vertical and Eroding - The bank is mostly uncovered as defined below and the bank angle is steeper than 80 degrees from the horizontal.

Streambank Stability Measurements

At each plot location, evaluate the condition of the streambank within the plot and record the stability class. If the plot along the greenline does not include the streambank, project the plot (50 cm) to the streambank and record the stability class. (see Appendix E, Figures 1 and 2)

Implementation Monitoring

Implementation monitoring measures attributes to help determine if livestock management is being applied as prescribed. It provides information to assist with making decisions under adaptive management. The three monitoring methods include stubble height, woody species incident of use, and streambank alteration.

Stubble Height

Objective: To determine the residual vegetation (key species) height remaining during the grazing season or after grazing is completed for the year.

Sampling is done using a “step-point” transect in the riparian area. For herbaceous key species, the sample area will be a 3-inch diameter circle directly in front of the sampler's toe. Because riparian key species may grow tightly together with no distinct separation of one plant from another, sampling usually does not try to separate out distinct plants. Using a ruler which shows quarters or tenths of an inch, measure several places within the circle to determine an "average" leaf stubble height (within one inch). Measure plants from the ground surface to the top of the remaining leaves. Account for very short leaves as well as the tall leaves. Do not measure seed stalks. The determination of an "average" stubble height will take some practice. Be sure to include all of the key species' leaves within your sample. The easiest method of doing this is to grasp the sample in the sampler's hand, stand the leaves upright and then measure the average height.

Measure a minimum of 30 samples per transect or sample more points on the transect if stubble height variability is high (100 is recommended). Once the samples are collected, the **median not the mean (average) height** is calculated for the riparian key species in the key area. Median riparian stubble height is calculated by listing, in ascending order of heights, from the measurement with the tallest height to the measurement of the shortest height. The median is the single mid-point for an odd number of samples and the average of the two "co" mid-points for an even number of samples.

Woody Species Utilization (Modified Extensive Browse Method)

General Description

The Extensive Browse Method provide a rapid method for determining woody species utilization, form classes, and hedging form class. Data is collected along the transect described above. Key species must be selected prior to gathering the data.

1. At each plot location along the transect, select the woody specie(s) nearest to the toe of the boot. The selection zone is a 180-degree arc in front of the observer within about one meter of the toe of the boot (see Figure 2).

2. The plant selected should be less than four feet tall. Plants over this height are out of reach for most animals. Randomly select a branch and determine the number of current year's growth shoots that has been used by large herbivores.

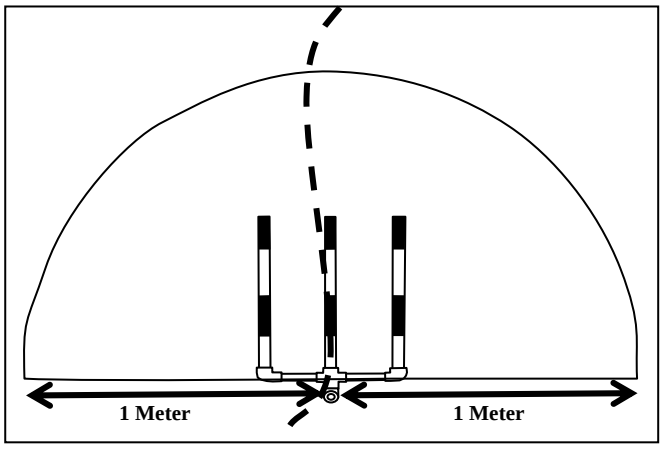

Figure 2—Select the nearest shrub, rooted or canopy cover, within 1 meter from the center of the monitoring frame near the toe of the boot. Select only shrubs less than four feet tall.

   a. Select a branch at random. One method of determining a random location is to use a clock with the direction of travel along the transect being the 6 o'clock to 12 o'clock line. Select a random number from 1 to 12 to determine the location for the sample. For example, if the selected number is 9, the 9 o'clock position is the location of the selecting the branch or branches necessary to look at 10 twigs. A random number table or generator may be used to determine the number. Another simple method is to use a second hand on an analog clock or the seconds on a digital clock. For example, 20 seconds represents 4 o'clock. Using a digital clock, round seconds to the nearest five second interval shown below.

0 = 12 o'clock	10 = 2	20 = 4	30 = 6	40 = 8	50 = 10
5 = 1	15 = 3	25 = 5	35 = 7	45 = 9	55 = 11

b. Evaluate ten leaders of annual growth for evidence of browsing. Indicators of browsing are the removal of the terminal growing bud and part or all of the current year's growth. Record the appropriate number on the form. (see Appendix H)

c. Observe and record the form class as described below (see Appendix F).

Class No.	Form Class
1	All available, little or no hedging
2	All available, moderately hedged
3	All available, severely hedged
4	Partially available, little or no hedging
5	Partially available, moderate hedging
6	Partially available, severely hedged
7	Unavailable
8	Dead

d. Availability refers to the current year's growth available for livestock use.

e. When more than one form class exists on a single plant, determine the predominant or average condition and record the appropriate form class.

f. Hedging is determined by the length and appearance of the two-year old wood immediately below the current year's leader growth. Hedging is described in three degrees of use, little or no hedging (Figure 2), moderately hedged (Figure 3, and severely hedged (Figure 4).

g. The length of the two-year-old wood reflects the relative vigor of the plant. Since hedging evaluated the two-year-old wood, it reflects the previous years use. The current years use is reflected in the utilization section.

h. The three degrees of use help evaluate the relative condition of browse plants and short-term effects of intensities of leader use.

Figure 3—Little or no hedging – Two-year-old wood is relatively long and only slightly unaltered. Most riparian species grow with a strong central stem with annual growth from a terminal bud. The central stem is relatively unaltered.

Figure 4—Moderately Hedged- Two-year-old wood is fairly long but most of it has been altered from the normal growth form. The central stem has multiple branching from the one point.

Figure 5—Severely hedged – Two-year-old wood is relatively short and/or strongly altered. Strong branching from a single point on the central stem is evident.

Streambank Alteration

General Description

The protocol describes a method that may be used to determine the percent of the linear length of streambank alteration that can be directly attributed to large herbivores, e.g., cattle, horses, sheep, bison, elk, and moose, during the current grazing season. As previously cited, bank alteration increases the risk of erosion caused by water, ice, and/or debris.

The part of the streambank that will be measured using this protocol is an area 20 cm on each side of the greenline. It focuses on that portion of the streambank that which is most subject to the erosive effects of water.

Streambank Alteration Definition

Streambank alteration occurs when large herbivores, e.g., elk, moose, deer, cattle, sheep, goats, and horses, walk along streambanks or across streams. The animal's weight can cause shearing of the streambank that causes direct breaking down of the streambank and widening of the stream channel. It also exposes bare soil which increases the risk of erosion to the streambank. Animals walking along the streambank may increase the amount of soil exposed to the erosive affects of water by breaking or cutting through the vegetation and exposing roots and/or soil. Excessive trampling causes soil compaction resulting in decreased vegetative cover, less vigorous root sytems, and more exposure of the soil surface to erosion.

Hoof shearing is usually the most obvious streambank alteration. It is recognized by the shear plane with obvious hoof marks on the streambank. Include the total length of

streambank disturbance directly associated with an occurrence of shearing, not just the width of the hoof mark.

Trampling is considered streambank alteration: 1) when streambanks are covered with vegetation and have hoof prints that expose at least 12 mm (about ½ inch) of bare soil and/or roots; 2) when streambanks with a broken vegetation cover or are not vegetated and have a hoof print at least 12 mm (½ inch) deep (Measure the total depression from the top of the displaced soil to the bottom of the hoof impression.); and 3) when streambanks with compacted soil are caused by large herbivores repeatedly walking over the same area is considered streambank alteration even though the animal's hoofs sink into and/or displace the soil less than 12 mm (½ inch).

Large herbivores trampling and trailing on top of terraces, above the active floodplain is not considered streambank alteration. Hoof marks indicating shearing on the streambank and or terrace wall and trampling at the base of the streambank or terrace wall is considered streambank alteration (see Appendix D, Figure 4).

Broken Vegetation Cover

Broken vegetation cover is small areas of vegetation mostly surrounded by bare ground. Patches are usually 12 inches or less in diameter in diameter. Generally the patches are caused by large herbivores trampling the area (see Appendix F, Figures 3 an d 4).

Streambank Alteration Monitoring Frame

The streambank alteration plot frame may be constructed from a number of materials. One-half inch Schedule 40 PVC pipe is a suitable inexpensive material. The plot is 20 cm X 50 cm on each side of the greenline. The plot contains five lines across the plot that is used to determine the amount of linear length that has streambank alteration. Appendix C shows some possible suitable configurations. A frequency monitoring frame, at least 40 cm X 40 cm, may be used by marking the frame appropriately.

Equipment

Streambank Alteration Form
Streambank Alteration monitoring frame
Existing photographs
Camera and film
Picture identifier (colored paper such as yellow or gray works well)

Procedure

The procedure should be used as one attribute that indicates that livestock management should be evaluated. It should not be used as the sole indicator of the need to move livestock. The recent studies found that the methods do not have adequate precision to set thresholds. In addition, there is little or not scientific data that provides a basis for establishing thresholds (Henderson, 2004). This procedure is most appropriately used in

conjunction with other indicators, e.g., stubble height, woody species utilization, greenline vegetation, and woody species regeneration), to review livestock management practices and make changes for future use.

The procedure should not be used if a high flow (flood) event occurs prior to monitoring. In that situation, water's energy and sediment will make it difficult, if not impossible, to determine if the effects are a result of the current grazing season or past grazing season.

1. Begin on one streambank and proceed along the streambank for at least 363 feet, about 110 meters (see Apendix C, Figure 1). Begin monitoring the transect by taking one pace from the monitoring location stake. Place the streambank alteration plot frame along the greenline and against the toe of the boot. (see Appendix B, Figure 2).

2. Looking down, determine the number of lines within the plot that intersect streambank alteration (see Appendix F). Record the number of lines that intersect streambank alteration in the appropriate column on the Streambank Alteration Form. Record only one occurrence of alteration, trampling or shearing, per line. This process is repeated every pace (two steps) for approximately 70 to 75 sampling points (depending upon the length of the step) on each side of the stream. **It is important that the observer determine only the current year's streambank damage and distinguish between livestock-caused and other alterations when possible.**

3. **Rules for consistency:**

    a. Place the center of the frame over the greenline and record the alteration information. This helps to maintain consistency in observing the portion of the bank most susceptible to an increased risk of damage.

    b. When there is a vertical or near-vertical terrace wall, pace along greenline on top of the terrace, placing the center of the frame along the greenline at the end of the toe. Record only direct alteration occurring on the terrace wall or the streambank.

    c. On streambanks with fully developed, deep-rooted hydric vegetation, *e.g.*, *Carex* spp., *Juncus* spp., and *Salix* spp., hoof prints or trampling is not recorded as alteration unless the plant roots are exposed. Hoof shearing along the streambank is alteration.

    d. Compacted livestock trails, *i.e.*, trails that have been created over some time by livestock walking along the same line, compacting the soil and excluding vegetation, that are on or cross the greenline and which were obviously used during the grazing season, are counted as trampling.

    e. Roads and tributary streams are not counted. Continue to pace directly across the area until the greenline in reached. Record separately on the form any samples that are on the road or water.

    f. When obstructions such as trees, shrubs, or other physical impediments are encountered, sidestep at 90-degrees from the transect line and continue pacing

parallel to the transect to avoid the obstruction. Project the lines from the end frame to the streambank and record the hits. Return to the original transect as soon as possible by sidestepping back to the transect line and continuing.

g. When the greenline is away from the stream channel or the edge of the terrace wall, the pacing should continue along the edge of the streambank or terrace wall (Appendix D, Figure 7)

Calculation

The percent streambank alteration is calculated by dividing the number of trampling and shearing instances on both sides of the stream by the total number of sample points (5 times the number of sample sites) on both sides of the stream and multiplying by 100.

Example

Number of of samples disturbed recorded (both sides of the stream)	= 357
Total number of samples points (5 sampling points per pace)	150 * 5 = 750
Total percent of the streambank disturbed	357 / 750 * 100 = 47.6%

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